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TURBULENT TRANSFER IN HEAT EXCHANGE, DIFFUSION, AND CHEMICAL PROCESSES

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[A Digest.]

The author previously showed, by averaging the kinematic coefficient ϵ of exchange, over the cross-section of a tube, how to obtain the following dimensionless parameters, with the help of which one can determine the effective coefficient of turbulent transfer in channels during steady-state motion for Reynolds numbers from Re $4 \cdot 10^3$ to $100 \cdot 10^3$.

$$\varphi \approx 0.116\ \mathrm{Re}^{-0.06} = \bar{\epsilon} / v_* r$$

$$\psi \approx 9 \cdot 10^{-3}\ \mathrm{Re}^{-0.16} = \bar{\epsilon} / \bar{U}_o d.$$

where $\bar{\epsilon}$ is the effective coefficient of turbulent transfer; $v_* = (\tau_o/\rho)^{\frac{1}{2}}$ is the "dynamic velocity" (τ_o, the tangential stress in the wall; ρ, the density); $\bar{U}_o$ is the average velocity over the channel cross-section; $r = d/2$ is the channel radius. (Gol'denberg. "Certain Experimental Laws of Turbulent Diffusion." Iz Ak Nauk SSSR, Otd Tekh Nauk, No 4, 1950.)

The problem in the present work is to examine to what extent the assumed averaging of the transfer coefficient actually corresponds with reality in respect to the following three elements: field of heat exchange; comparison with experimental results in turbulent diffusion; comparison with chemical processes which are determined mainly by turbulent processes and which are independent of kinetics at the reacting surface.

It is concluded that (a) the coefficient of turbulent diffusion, obtained experimentally in various channels for gases, water vapor and fluids by direct

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measurements of the concentration fields, and (b) the integral coefficient of turbulent transfer of momentum, obtained by the applied method of averages with certain simplifying approximations, sufficient, however, for practical computations, are approximated by a general empirical equation for values of Reynolds number from 4,000 to 100,000; when Re is greater than 400,000, then the dimensionless parameter ψ is practically independent of Re. It is also found that the dimensionless parameters, ψ , φ , η obtained in the first work can describe (a) the processes of heat exchange of a gas in cylindrical pipes; (b) the processes of mixing of gases, and (c) the chemical processes mentioned.

The author was assisted by Corresponding Member of the Academy of Sciences, USSR, A. S. Predvoditelev and Doctor of Technical Sciences L. N. Khitrin.

Submitted by Academician M. V. Kirpichev
2 January 1950

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